Research is a careful investigation or inquiry specially through search for new facts in any branch of knowledge. It is a systematized effort to gain new knowledge and also a movement from the known to unknown. In the Encyclopaedia of Social Sciences,D.Slesinger and M.Stephenson define research as "the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art". It provides the basis for nearly all government policies in our economic system. It has its special significance in solving various operational and planning problems of business and industry. It is equally important for social scientists in studying social relationships and in seeking answers to various social problems. The general procedure in scientific research is to formulate hypothesis and then to verify them directly or by their consequences. This verification necessitates the collection of observations, and the design of the experiment is essentially the pattern of the observations to be collected. The purpose of the theory of the design of experiments is to ensure that the experimenter obtains data relevant to his hypothesis in as economical a way as possible.

Statistical Design of Experiments : Statistical Design of experiments refers to the process of planning the experiment so that appropriate data that can be analyzed by statistical methods will be collected, resulting in valid and objective conclusions. The statistical approach to experimental design is necessary if we wish to draw meaningful conclusions from the data.When the problem involves data that are subject to experimental errors, statistical methodology is the only objective approach to analysis. Thus there are two aspects to any experimental problem: the design of the

experiment and the statistical analysis of the data. These two subjects are closely related because the method of analysis depends directly on the design employed.

A statistical design of experiment is usually characterized by size, number of experimental units, the procedure of allocation of treatments to the experimental units and the nature of blocking etc. in agricultural and biological experiments. For such type of experiments it will not be possible to use large blocks in order to accommodate all the treatments in each block. So we generally prefer incomplete block designs. If all the treatments are not used in each block of the plan of a design, then it is called an incomplete block design. Incomplete block design is an arrangement of v treatments in b blocks each of size k_j ($k_j <$ v) such that each of the v treatments is replicated r_i times, r_i and k_j may be equal or unequal where v, b, r_i and k_j are the parameters of the design and $i = 1, 2, \ldots,$ v, $j = 1, 2, \ldots,$b. When all the pairs of treatments in a design occur together the same number of times (say, λ) and r_1=r_2=...=r_v=r, k_1=k_2=...=k_b=k then the incomplete block design becomes balanced incomplete block design (BIBD). It was first introduced by Yates (1936) for agricultural experiments. For balanced incomplete block designs, all elementary contrasts are estimated with the same precision. Constructional problems were developed by Bose (1939). Fisher and Yates (1973) prepared an extensive table of balanced incomplete block designs. It was further extended by Cochran and Cox (1957). Rao (1961) studied the BIB designs with replications 11 to 15. It was noticed that the balanced incomplete block designs are not available for every parametric combination. To overcome such difficulties, Yates (1936) developed another series of incomplete block designs, which Yates called Lattice designs. Lattice designs have the drawback

that they are available for the number of treatments, which are perfect squares or cubes. This limitation was removed by Bose and Nair (1939) by introducing another class of incomplete block designs which they called Partially Balanced Incomplete Block Designs with m associate classes, abbreviated as PBIBD (m).

Further Bose and Shimamoto (1952) classified PBIBD (2) in to the following five categories on the basis of their association schemes.

i. Group Divisible Designs

ii. Simple Designs

iii. Triangular type Designs

iv. Latin square type Designs

v. Cyclic Designs.

Group Divisible Designs: A partially balanced incomplete block design with two associate classes is said to be group divisible if there are v=mn treatments and the treatments can be divided into m groups of n treatments each, such that any two treatments of the same group are first associates and two treatments from different groups are second associates.

Depending upon the characteristic roots of the information matrix, a group divisible design is said to be

1. singular if r-λ_1=0

2. semi regular if r-$\lambda_1 > 0$ and rk-vλ_2=0

3. regular if r-$\lambda_1 > 0$ and rk-v$\lambda_2 >$0.

Generalized Group Divisible Design: Let d(v,b,k) be any design having v treatments arranged in b blocks of size k. Then d is a generalized group divisible design with s groups (GGDD(s)) if the treatments in d can be divided into s mutually disjoint sets V_1, V_2, ...,V_s of size v_1, v_2, ...,v_s respectively such that

1. for i=1,2,...,s and for all a $\in V_i$, r_{da}=λ_{da}=r_i, where r_i is a constant.

2. for i,j=1,2,...,s and for all a $\in V_i$, b $\in V_j$, $a \neq b$, $\lambda_{ab} = \lambda_{ij}$ where λ_{ij} depends only on the groups V_i and V_j.

Existence of Group Divisible Designs: Fu et. al. (2000) settled the existence problem for GDDs with first and second associates with block size k = 3 and with m groups each of size n with m, n $\geq$ 3. The problem of necessary and sufficient conditions for m = 2 or n = 2 and block size 3 was established by Fu and Rodger (1998). Hurd and Sarvate (2004) established some necessary conditions for the existence of group divisible designs.

Methods of Constructing Group Divisible Designs: Bose, Shrikande and Bhattacharya (1953) have described a number of methods of constructing group divisible designs from known BIB designs and also using the method of differences.

Methods of Constructing Generalized Group Divisible Designs: Construction of generalized group divisible design was investigated by Jacroux (1982), Srivas-

tav and Morgan (1998, 2002), Srivastav (2002) and Srivastav and Shankar (2005) and some methods of construction of generalized group divisible designs were developed.

Optimality of Block Designs: In the early stages of experimentation, only a few experimental designs were at one's disposal. But now-a-days, an experimenter with modern statistical equipments at his disposal, can use a variety of experimental designs. Hence whenever the conditions of an experiment allow the possibility of simultaneous existence of a number of experimental designs, the question of selection of an appropriate design, a design that is easy to analyze and which has some optimum properties, naturally arises. A systematic study of the specification of optimum experimental designs was undertaken by Kiefer (1958, 1959) in a series of papers, where he introduced various optimality criteria (A, D, E, L, M), discussed interrelations amongst these and established the optimality property of some well-known designs in some particular problems.

Summary of the present study: In the present investigation, we have developed some new methods of construction of generalized group divisible designs. In chapter 1, we explain the basic concepts of Design of Experiments and give a brief summary of our investigation. In chapter 2, we give a few preliminary definitions and explain some concepts required in the later chapters. We have developed some new methods of construction of Generalized Group Divisible Designs. In chapter 3, a method based on Group Testing Designs is explained. In chapter 4, we present a method of construction of generalized group divisible designs from balanced incomplete block designs. A method based on Group Divisible Treatment Designs and Group Testing Treatment Designs is explained in chapter 5. The E - optimality and MV - optimality

of the class of generalized group divisible designs constructed in chapters 3, 4 and 5 are discussed in chapters 6 and 7 respectively. The analysis of generalized group divisible designs is explained in chapter 8. Numerical examples have also been illustrated to support the theories which we have developed. An article based on the findings of chapter 3 was published. Articles based on chapters 4, 6 and 7 are to appear.